Clinical and experimental aspects of tracheal stenosis
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Carotid Artery Patch Plasty as a Last Resort Repair for Long-Segment Congenital Tracheal Stenosis

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Abstract

Complete congenital tracheal rings represent a rare but life-threatening cause of respiratory distress in neonates and infants. Surgery may be required in an emergency setting, using established techniques and repair materials. In an infant with long-segment tracheal stenosis whose extent was underestimated by conventional diagnostic work-up, standard repair materials were unavailable. This case report illustrates an unusual surgical technique in a bail out situation, using autologous left carotid artery to patch a large tracheal defect.
A previously healthy four-month-old girl presented with acute respiratory distress and exhaustion, mandating intubation and mechanical ventilation. The chest x-ray revealed bilateral air-trapping and right upper lobe consolidation. Sputum cultures were positive for adenovirus and Neisseria branhamella. Tracheo-bronchoscopy revealed tapering stenosis of the trachea, beginning 2 cm beyond the vocal cords. As it was impossible to advance the smallest telescope, the distal extent of the stenosis remained undefined. A thoracic CT-scan demonstrated long-segment tracheal stenosis, but the carina and the main bronchi seemed normal. A tracheo-bronchography was therefore not performed. Sudden uncontrollable respiratory deterioration with increased mean airway pressures, as well as ongoing sepsis, made the patient highly unstable. Extracorporeal membrane oxygenation (ECMO) was unavailable at our institution, and emergency intratracheal balloon dilation or stenting seemed unreasonable, without full anatomical knowledge of the lesion, making emergent surgical intervention inevitable.

We proceeded with salvage surgery in a 5.4 kg infant, through an expeditious median sternotomy, with cannulation of the aorta and right atrial appendage, normothermic cardiopulmonary bypass and a beating heart. Intraoperatively, it was for the first time possible to pass the bronchoscope beyond the proximal portion of the stenosis, revealing complete congenital tracheal rings, extending down to the carina. This new evidence was in contradiction with previous diagnostic information. Resection and end-to-end anastomosis or slide tracheoplasty seemed inappropriate. We opted for patch reconstruction, but the remaining pericardium following the hasty sternotomy appeared damaged, thin and unsuitable. The infant's septic condition made xenopericardium or synthetic patch material undesirable, and no tracheal

Figure 1. Anterior incision into the stenotic portion of the trachea. The anticipated incisions in the left common carotid artery and left subclavian artery are demonstrated by the dotted lines. Inset shows the completed tracheal repair with the patch of carotid artery, and anastomosis of the left subclavian artery to reestablish distal left common carotid artery perfusion. LCCA: left common carotid artery, LSCA: left subclavian artery.
homograft was available. The trachea was opened anteriorly and longitudinally. An arterial conduit was selected as a last resort graft material. The left common carotid artery (LCCA) was harvested from its aortic arch origin, to its disappearing point under the mandible (Figure 1). The artery was opened longitudinally and sutured to patch the tracheal defect with its endothelial side towards the airway lumen (Figure 1 inset). The left subclavian artery (LSCA) was fully mobilized to its thoracic exit, transected, and an end-to-end anastomosis to the stump of the LCCA was performed (Figure 1 inset). To achieve stenting of the tracheal repair, the carotid patch was pexed to the aorta and adjacent mediastinal tissue, pulling it anteriorly towards the sternum. Intraoperative bronchoscopic control confirmed a widely patent repair. Weaning from cardiopulmonary bypass, protamine, decannulation and chest closure were without incident. An uneventful postoperative course allowed extubation on postoperative day 7, and discharge from the hospital on postoperative day 16, after satisfactory CT-scan control of the repair (Figure 2).

Current follow-up 3 years after surgery reveals a normally developing, and neurologically intact child. She is completely asymptomatic, and the physician parents find no justification in control bronchoscopy. The function, growth, and perfusion of her left arm are normal and comparable to the contralateral arm.

Figure 2. Three-dimensional CT-scan reconstruction two weeks post-operatively. Note the patent but narrowed airway at the distal end of the repair. The flailing carotid artery patch subsequently became appropriately rigid with conservative management.

Comment

Diffuse stenosis from complete congenital tracheal rings remains a rare but challenging problem in neonates and infants, best diagnosed and managed in a multidisciplinary manner. Diagnostically, the indications for tracheo-bronchography should be appropriately widened.
This was not performed in our patient, but would have allowed visualization of the distal extent of the stenosis, avoided unnecessary surprises, and permitted better planning for alternative patch materials than the one finally used.

Beyond surgical preference, tracheal anatomy and the availability of reconstruction materials may dictate the type and extent of repair. Although the techniques of resection and end-to-end anastomosis, slide tracheoplasty, pericardial patch plasty, tracheal homograft, and autograft reconstruction were known to the authors, they were either unsuitable or impossible at the time of surgery. Excessive anastomotic tension would have made resection and end-to-end anastomosis, slide tracheoplasty, or autograft reconstruction hazardous. The remaining autologous pericardium was either damaged or excessively thin, and tracheal homograft was unavailable. The carotid artery was readily available, had the desired curvature, and was technically easy to handle. It is endothelialized, has sufficient tensile strength and is autologous material. We were concerned enough to prefer sacrifice of the left subclavian artery for carotid artery reconstruction. More recent data from the neonatal and infantile ECMO experience suggests the safety in temporarily using carotid arteries, as they are routinely repaired after weaning from ECMO.

We acknowledge the radical nature of this repair technique, but present it as a last-resort option in emergency settings, when more conventional types of surgery cannot be achieved. This may be due to misdiagnosis, unavailability, or inappropriateness of more standard reconstruction materials.

References